Space Weather Technical Forecast

Issued on Sunday, 20 November 2022 at 12:59 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Storms, mainly day 1 (20th), before reducing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at Moderate levels, with one M1.6 flare observed from AR3150 Dai/Beta in the northwest disc at 19/1256 UTC, along with occasional C-class flares. Areal growth of this region has stalled, however it continues to spread with the potential for further development. There are a total of four sunspot regions on the disc, with three further numbered regions in the eastern hemisphere, although these are generally stable. AR3147 Cso/Beta in the southeast is the largest region, originally unipolar but having gained a small trailer spot, whilst AR3148 Cro/Beta further south is a smaller region. AR3149 Cai/Beta in the northeast has seen some growth with a more distinct trailer spots developing. This will need to be monitored for further development. A number of CMEs were observed in the last 24 hours, including one from the M1.6 flare, and from filament eruptions in the north and far south disc. These have been assessed as likely missing the Earth, although slight glancing impacts are possible on the 22nd. We also await further imagery to assess a possible small CME associated with a recent C-Class flare from AR3150 in the northwest disk.

Solar Wind / Geomagnetic Activity: Solar winds measured by ACE and DSCOVR at L1 remained indicative of the slow wind. Speeds persisted at background levels of around 320-340km/s, whilst its density varied from below average to just above average values with peak 18 ppcc early in the period, though we have seen a rising trend in recent hours. The total interplanetary magnetic field (IMF) Bt, was Moderate at first at 10-12nT, but eased to be weak. The north-south component, Bz, was predominately positive (northward) peaking +6nT, with only a very brief spikes to negative (southward) values, reaching a minimum of -4 nT. The phi angle was negative (towards the Sun) throughout. The resultant geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2 MeV) at GOES16 was at Background. Electron fluence levels remained well below Active (1e8 integrated pfu) levels. Observed fluence at 20/1200 UTC was 1.48e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low with a daily slight chance of rising to Moderate, with an ongoing potential for isolated M-flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs, however glancing interactions from the passing but missing CMEs on day 3 (22nd) are not impossible. Otherwise initially background winds are likely to become enhanced due to the arrival of the fast wind from CH46/- later day 1 (20th), perhaps preceded by a CIR region. Peak winds of 500-600km/s are possible day 2 (21st) before easing later in the period. Geomagnetic activity is expected to increase through day 1 (20th) from Quiet to be Unsettled to Active with a chance of G1/Minor

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Storm intervals, these also possible day 2 (21st) with ongoing fast winds. Conditions then easing to mostly Quiet with isolated Unsettled intervals day 3 (22nd) onward.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at Background levels throughout. Electron flux is forecast to be initially at Normal Background, but with a Chance of rising to Moderate, perhaps High, later in the period as solar winds ease after any enhancement from the arrival of CH46/- fast winds. Fluence values are expected to remain below the Active (1e8 integrated pfu) threshold throughout, but with a chance of rising above by day 4 (23rd).

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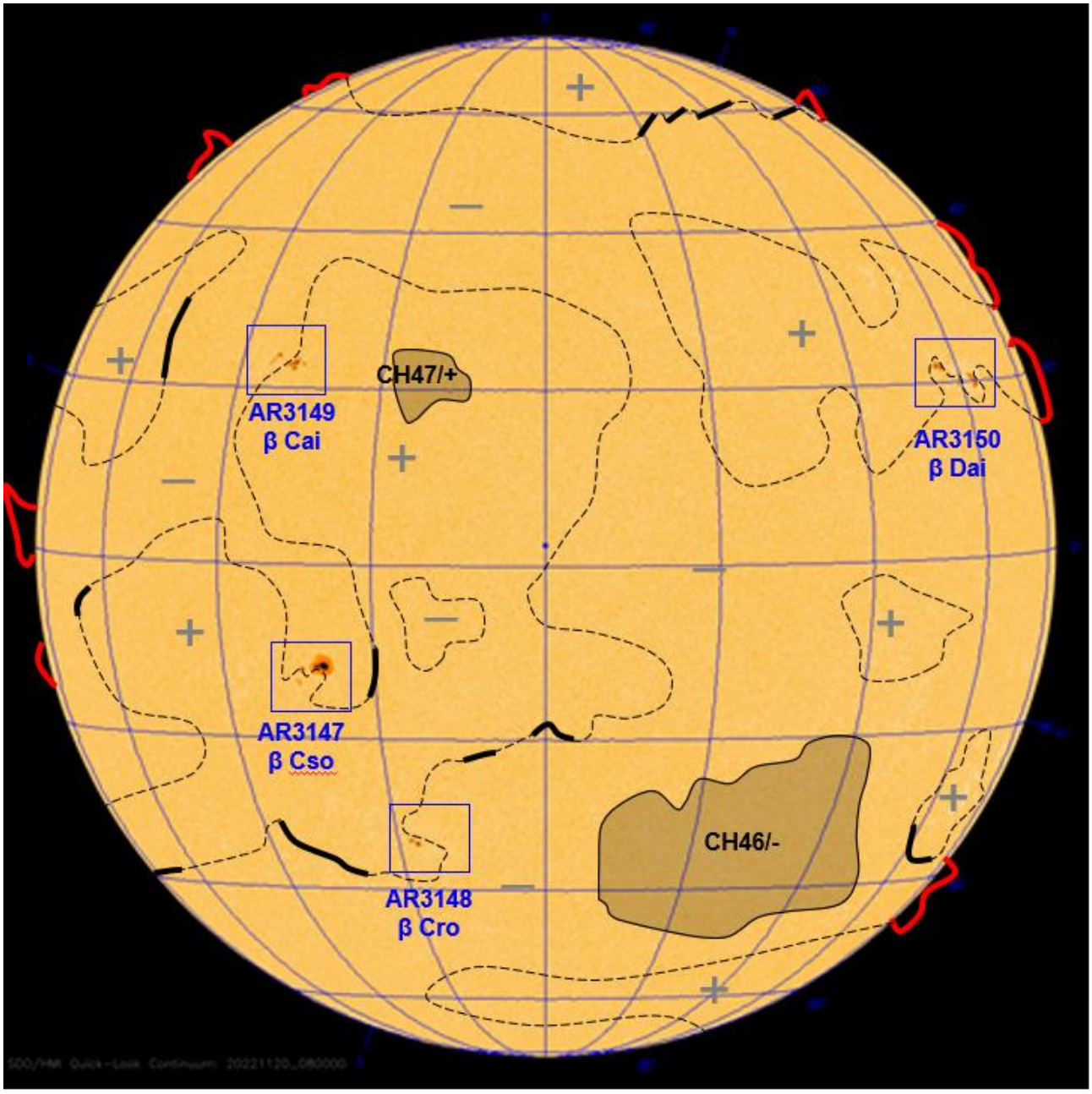
Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no significant Earth-directed CMEs currently forecast, however slight glancing impacts cannot be completely ruled out day 3 (22nd), due to CMEs from the filament eruptions on the 19th passing north of Earth but close by. We also await further imagery to assess a possible small CME associated with a recent C-Class flare in the NW disk.

Solar winds are currently at background with the next significant enhancement expected to be due to interaction with fast winds associated the high speed stream (HSS) of negative polarity coronal hole 46 later day 1 (20th) and into days 2 and 3 (21st-22nd), although the strength of this arrival is low confidence.

Coronal hole 46 is a broad feature is the southern hemisphere with 27-day persistence suggesting the arrival of any associated Co-rotating Interaction Region (CIR) ahead of the HSS to have already occurred early on the 19th, whilst ENLIL has the associated arrival early day 1 (20th). Despite the unfavoured time of year for a strong geomagnetic response, persistence perhaps indicating a stronger response than would otherwise be expected. ENLIL indicates a potential for solar winds to peak at around 600 km/s by day 2 (21st), before easing gradually day 3 (22nd) onwards. Current wind speeds are lower than ENLIL expectations however, which further reduces confidence. STEREO data looking to be of limited use due with the bulk of the HSS seemingly passing to its south.

Quiet geomagnetic activity at first is expected to be followed by a period of Unsettled to Active with a chance of G1/Minor Storms, later on day 1 (20th) and into day 2 (21st) with the expected arrival of faster winds. Conditions then easing to mostly Quiet with isolated Unsettled intervals day 3 (22nd) onward, though minor CME affects remain under consideration.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity – Earthbound Coronal Mass Ejections

Nil.

Figure 2: ENLIL ensemble output showing the expected increase in solar wind speeds through 20th/21st and a slight chance of CME impacts on the 22nd.

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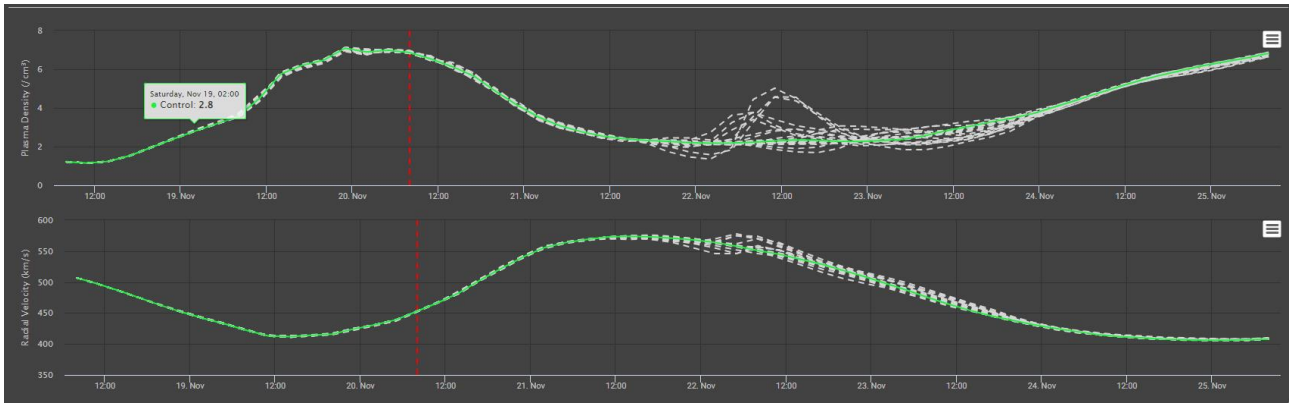

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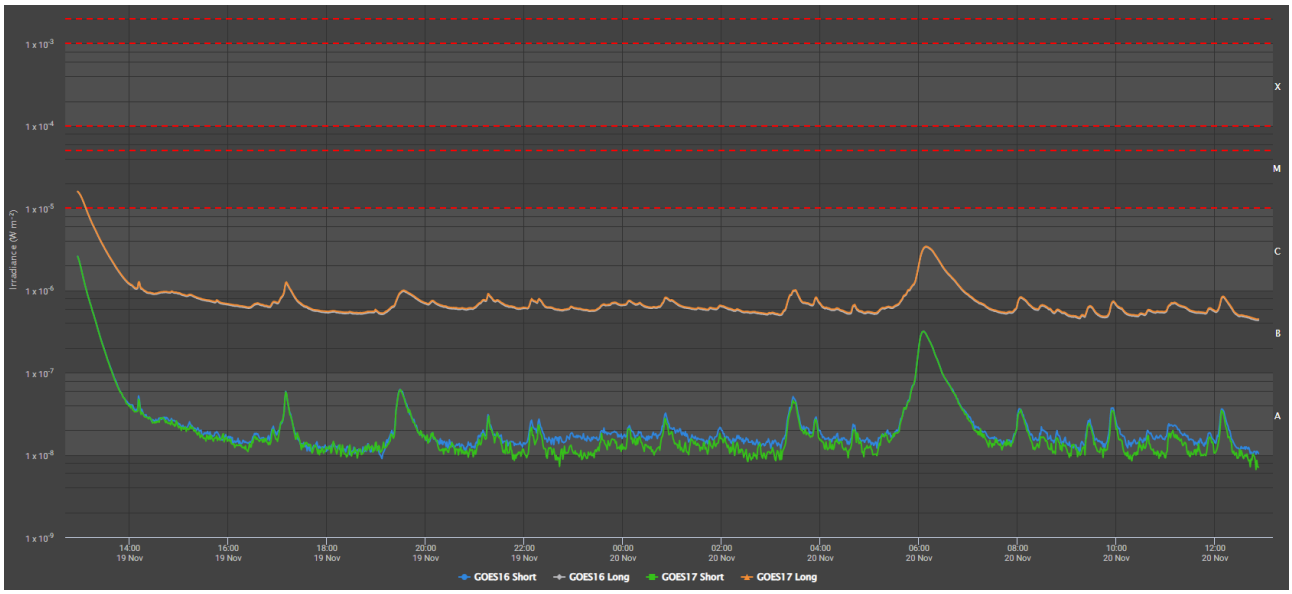
Radio Blackouts - X-Ray Flares:

Solar activity is currently Moderate with one M1.6 flare observed in the last 24hr from AR3150 Dsi/Beta in the northwest disc. Activity is currently expected to be predominately Low throughout, but with an ongoing daily slight chance of reaching Moderate with the occurrence of isolated M-flares.

AR3150 remains the most likely source of any flaring, as a small but active region with ongoing development albeit with recent areal growth now largely stalled. The other persistent regions, all in the eastern hemisphere, have been largely benign, with only small fluctuations in size and shape. No significant new regions expected to rotate onto the visible disk during the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	20	20	15	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/17 X-ray Flares



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background and expected to persist at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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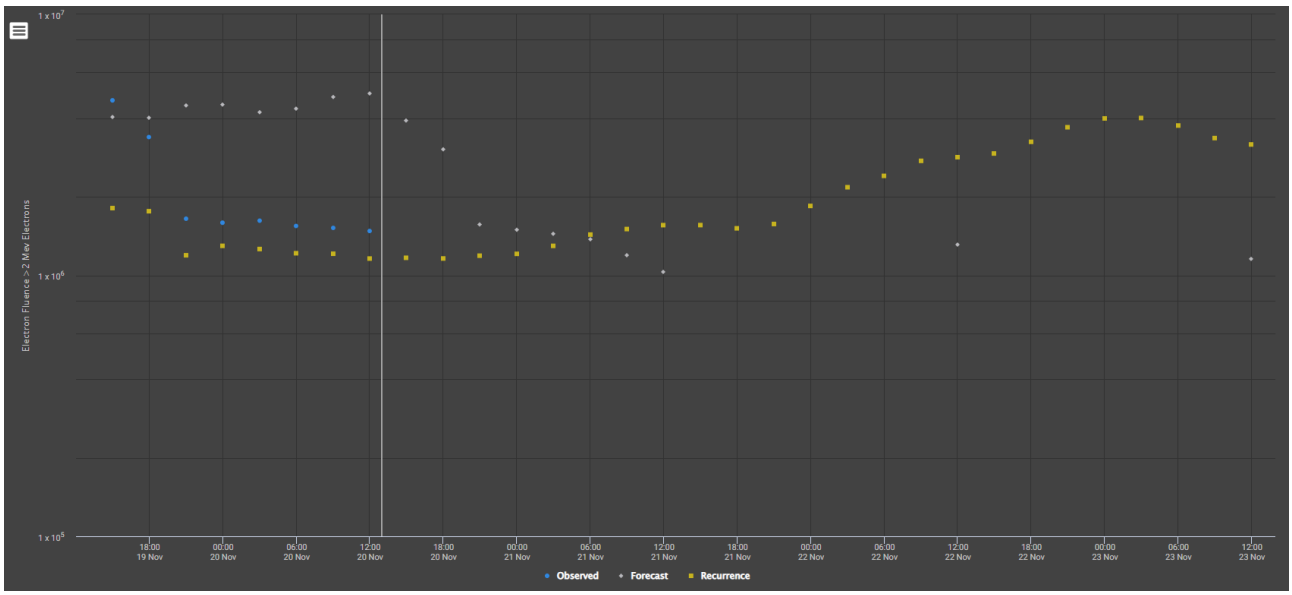
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 is at mainly Background, briefly Moderate levels. The forecast solar wind enhancement later day 1 or into day 2, through to day 3 (20th-22nd) has the potential to increase the electron content in the Van Allen belts, although these are likely to initially be compressed inside of GEO. As solar wind pressure eases later in the period, the observed flux is likely to rise, perhaps reaching Moderate to High levels. The strength of any response is very low confidence however, with no increased flux observed on the previous pass of this coronal hole, 27 days ago.

The associated 24-hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold, but with a chance of rising above by day 4 (23rd). REFM is currently giving good guidance, however this will become less reliable with the expected solar wind enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	15	25
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest REFM model output.



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